"On a Re-determination of the Principal Line in the Spectrum of the Nebula in Orion, and on the Character of the Line." By WILLIAM HUGGINS, D.C.L., LL.D., F.R.S., and Mrs. HUGGINS. Received March 20,—Read June 12, 1890.

We think it desirable to put on record the results of a re-determination of the position of the principal line in the spectrum of the nebula in Orion, under the more favourable conditions of a higher position of the nebula, and of some improvements in the instrumental arrangements.* The spectroscopes have been furnished with new and sensibly perfect object-glasses by Sir Howard Grubb, and a new bright pointer has been fitted to the spectroscopes by Mr. Hilger, which is illuminated by a small incandescent lamp, of which the brightness is controlled by suitable resistances. In all other respects the instrumental arrangements have remained unaltered. The same spectroscope, giving a dispersion of about four prisms, which was described in my paper of 1872 as Spectroscope B,† and was used in the work on this line contained in my paper of 1874,‡ and also throughout the work of last year, with the exception of one single confirmatory observation with a more powerful spectroscope,§ was employed in the present investigation, and also the same arrangements for the comparison spectrum from burning magnesium.

In my earlier spectroscopic work I pointed out that a possible parallactic error of the comparison spectrum may easily come in when a small reflecting prism is placed in the usual way before one half of the slit; and also the possibility of errors from the unavoidable flexure of the spectroscope or of its attachments to the telescope. In 1872, I adopted the plan of placing "the spark or vacuum-tube within the telescope at a moderate distance from the slit. For this purpose holes were drilled in the telescope-tube, opposite to each other, at a distance of 2 feet 6 inches within the principal focus. Tubes were fixed by screws over these holes, and in these tubes slide suitable holders for

* [In a communication last January to the Royal Society, Professor Lockyer stated that he and his assistants had by different methods and with great dispersion compared directly the chief line in the spectrum of the Nebula in Orion with the band of the magnesium-flame spectrum, and that they had found perfect coincidence between the nebular line and the terminal line of the band. Professor Lockyer also stated that they had always seen the line as a fluting. These statements being in direct contradiction to my early observations and to the conclusions of our paper of last year, the necessity was thrown upon us of going over our work again.—July 4.]

† 'Roy. Soc. Proc.,' vol. 20, 1872, p. 382.

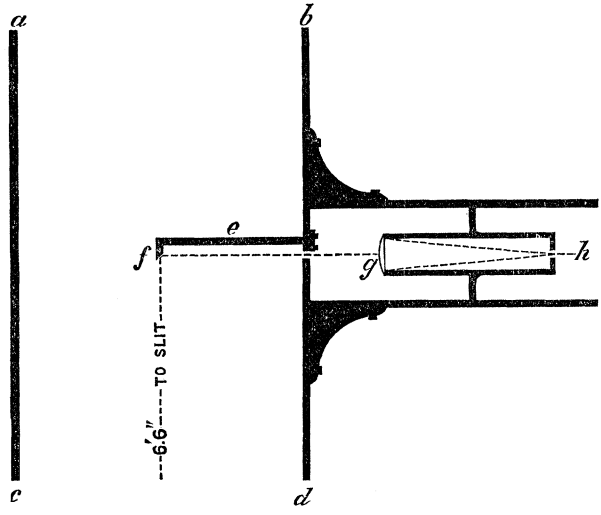
‡ 'Roy. Soc. Proc.,' vol. 22, 1874, p. 252.

§ 'Roy. Soc. Proc.,' vol. 46, 1889, pp. 50, 51.

carrying electrodes or vacuum-tubes. The final adjustment was tested by the comparison of the bright lines of magnesium and the double line of sodium with the Fraunhofer lines *b* and D in the spectrum of the Moon."*

I have since adopted an arrangement in which, when once adjusted, any sensible parallactic effect from a change of position of the source of light seems to be impossible, for even a minute motion of the spark or other source of light for comparison has the effect of throwing the light to one side, without the slit; so that, as long as the comparison spectrum is seen, there can be no doubt that the direction of the light for comparison, as it fell upon the slit, had remained invariably the same, relatively to the optical axis of the telescope, and consequently to the celestial spectrum under observation.

In the diagram, *abcd* represents a section of the telescope-tube near the middle of its length; within this is firmly screwed a thin



steel arm, *e*, carrying a minute mirror, *f*. This mirror is about a quarter of an inch in width, and of about the same apparent length, when seen fore-shortened from the slit. The mirror is fixed at a distance of 6 feet 6 inches within the principal focus, where the slit is placed. In the side of the tube opposite the face of the mirror is a small hole, through which the light from the collimator *g* passes on to the mirror. At the other end of the collimator, which has a length of about 7 inches, is a diaphragm with a small hole, *h*, before which the source of light, whether an induction spark, a vacuum-tube, or

* 'Roy. Soc. Proc.,' vol. 20, p. 382.

burning magnesium, is placed. The lens at *g* is so placed as to bring the light approximately to focus at the place of the slit.

It is obvious that with this arrangement an extremely small shift of the light before the hole *h* would be sufficient to cause the ray reflected from the mirror to go off the slit, and that the reflected light can pass into the slit only so long as its direction remains sensibly invariable relatively to the optical axis of the telescope. It is also obvious that any flexure in the spectroscope, or in the tube connecting it to the telescope, would affect similarly the light from the nebula and from the magnesium. The precaution was taken, however, to so orient the spectroscope, that any flexure from the weight of the instrument would be in the direction of the length of the slit.

The coincidence or otherwise of the direction of the light reflected from the little mirror with the optical axis of the telescope can be determined by comparing the spectrum of burning magnesium with *b* in the spectrum of the Moon, or in that of the light of the sky. As an additional safeguard in the comparison of the spectrum of the nebula with magnesium, since my early observations had shown the nebular line to be very slightly more refrangible, the mirror was purposely so adjusted that, though the lines of the burning magnesium were seen to fall upon the corresponding dark lines *b* in the Moon or sky, yet a careful observation would show a very minute overlapping of the bright lines towards the blue. This state of things would diminish a little the interval which should be seen between the nebular line, and the termination of the magnesium-flame band and so make the observation more difficult. It is evident that if under such circumstances of adjustment the nebular line were seen on the more refrangible side of the magnesia band, the observation, being a delicate one, would be more trustworthy, for in the case of coincidence with magnesium the line would appear towards the opposite and less refrangible side of the magnesia line, broadening the line towards the red (*loc. cit.*, p. 49).

The stability of this adjustment depends upon the rigidity of position of the little mirror within the telescope; as this weighs only a small fraction of an ounce, and is supported by a strong steel arm firmly attached by four screws to the steel tube of the telescope, there is an almost complete absence of any chance of its displacement. During twelve months not the smallest alteration has been detected, though very careful examinations have been frequently made.

At the time the comparisons were made last year, namely, in March, the nebula was getting low, and from perhaps an excess of caution I described them as follows: "Although I consider the results to be satisfactory, I prefer to say that I and Mrs. Huggins, independently, believed fully at the time that we saw the appearance which all former observations of the line led me to expect, namely,

the nebular line to fall within the termination of the magnesium band" (*loc. cit.*, p. 49).

This year the position of the nebular line within the termination of the magnesia band has been confirmed by both of us independently on several nights.

The more refrangible position of the nebular line relatively to the termination line of the MgO band has been ascertained not only by repeated comparisons of the two spectra by means of a suitably illuminated pointer, but also this year, as last year, by occasional moments of direct vision of the nebular line upon and within the magnesia band. It is only occasionally that the necessary relative brightness of the band can be secured, but such moments of direct vision of the two spectra are very trustworthy.

On February 9th, Professor Liveing made some observations on the spectrum of the nebula, and I have his permission to quote from the notes which he entered at the time in my observatory book. During the afternoon he examined the adjustments of the little mirror. His words are: "Observed in Dr. Huggins' spectroscope attached to his telescope the Fraunhofer lines *b*, as given by the clouds, and the bright lines of burning magnesium thrown in by reflexion. The solar spectrum was but faint, so that it was necessary to use rather a wide slit. I observed a close coincidence between the dark lines of the sky light and the bright lines of the burning magnesium; the two overlapped, but the dark lines extended a very little on the less refrangible side, the brightest line a very little on the more refrangible side beyond the dark line."

In the evening he observed the nebula, and recorded his observations in the following words:—"Observed the spectrum of the nebula in Orion, and compared the position of the least refrangible line with the magnesia fluting. The latter was thrown in by reflection from burning magnesium. I put the nebular line on the pointer first, and then from time to time the magnesium was burnt. I made quite sure that the edge of the magnesia fluting was less refrangible than the nebular line; repeated the observations several times. Tried to see both the nebular line and the fluting at the same time, but found it hard to see both at once, but I still came to the same conclusion, namely, that the edge of the fluting was less refrangible than the nebular line."

Afterwards, Professor Liveing observed the third line of the nebula, together with Hβ from a vacuum-tube. He says:—"Compared the position of the most refrangible of the nebular lines with the F line of hydrogen thrown in by reflexion from a vacuum-tube, the coincidence seemed perfect, the one line falling upon the other."*

* [On April 29, Professor Liveing was kind enough to go over again with us the arrangements for the comparison spectrum, and, in particular, to see if any error

We have since gone further, and attempted a quantitative estimation of the distance of the nebular line within the termination of the band. For this purpose we made use of the minute apparent breadth of the illuminated pointer-tip as a measuring unit. The value of this unit was determined by measuring with it the distance of b_3 from b_4 in the solar spectrum.

Independent estimations made by both of us on several occasions agreed in assigning to this distance, after taking into account the minute displacement of the comparison-spectrum by the little mirror towards the blue,

A wave-length of about ..... λ 0001·5.

Deducting this distance from λ 5006·5, the position of the termination of the band, we get for the nebular line

A position of about ..... λ 5005·0.

At the time of these observations the earth's motion caused the nebular line to be degraded towards the red by about λ 0000·25. If, therefore, the Great Nebula has no motion of its own, this interval must be deducted from the observed position of the nebular line,

Placing it at about ..... λ 5004·75.

The observations recorded in the paper of 1874* gave the position of the nebular line relatively to the fiducial lead line with an accuracy not less than λ 0000·5. This relative position was translated into wave-lengths in our paper on the Nebula (*loc. cit.*, p. 45), showing that the nebular line lies from about λ 5004·6 to about λ 5004·8.

The question whether this nebula has a motion in the line of sight

could possibly arise from a change of position of the magnesium during its burning. After a detailed account of the experiments, he wrote in my note-book:—"I could not detect any shift; and I came to the conclusion that there is no sensible shift due to moving the burning magnesium. I next compared the position of the lead line near the edge of the MgO band, as seen in the same spectroscope detached from the telescope, with the said edge of the band. Both could be seen at the same time, and the apparent distance between them was so great that even if there should be some shift of the lines from the method of throwing in the light when the spectroscope is attached to the telescope, I am satisfied that it could not amount to anything comparable with the distance between the lead line and the edge of the MgO fluting. So far as my memory will serve, the distance from the edge of the MgO fluting at which the nebular line appeared when I observed it on February 9 was not far short of the distance now observed between the lead line and the edge of the MgO fluting."—July 4.]

* 'Roy. Soc. Proc.,' vol. 22, 1874, p. 254. This paper claims for the determination of the position of this line in the case of seven nebulæ an accuracy sufficiently great to show a motion of 25 miles per second. This motion corresponds to about λ 0000·67, but as some of the nebulæ were more difficult to observe than the bright nebula in Orion, the accuracy of the determination of the line in this nebula may certainly be taken as not less than the amount given in the text, namely, λ 0000·5.

must be determined by comparisons of the third line with the corresponding bright line of a hydrogen vacuum-tube. The observations I recorded in 1874, as well as those of Mr. Maunder, of Greenwich (*loc. cit.*, p. 60), "show that the nebula has very little, if any, sensible motion in the line of sight."

The direct comparison was made on several nights with results similar to the observation that Professor Liveing recorded on February 9, namely, that "the coincidence seemed perfect, the one line falling upon the other."

We have endeavoured to push this observation further, to determine if the coincidence was absolute, or whether there was a very minute overlapping of the edges of the two lines. The adjustment of the apparatus would throw the hydrogen line, to a very minute extent, towards the blue, at the same time that the earth's motion would degrade the nebular line from the hydrogen line towards the red.

The faintness of the third line with a narrow slit does not permit us to speak with absolute certainty as to the extent which the hydrogen seemed to overlap the nebular line towards the blue.

We were quite certain that the hydrogen line did overlap the nebula slightly towards the blue, but we were unable to determine whether the overlapping corresponded accurately to the earth's motion at the time of observation. It appeared to do so approximately, which would support my former conclusion, that the "nebula has very little, if any, sensible motion in the line of sight."

Part II.

On the Character of the Principal Line in the Spectrum of the Nebula in Orion.

In our paper last year (*loc. cit.*, p. 53) I stated that "my own observations of this line, since my discovery of it in 1864 . . . . . show the line to become narrow as the slit is made narrow, and to be sharply and perfectly defined at both edges." We gave also the corroborative evidence of two accurate observers who have made a special study of the spectrum of the gaseous nebulæ, Professor Vogel and Dr. Copeland.

Since last year the defining power of the spectroscopes has been improved by two new object-glasses by Sir Howard Grubb. The nebular line has been subjected on several nights to a very searching examination with different widths of slit; and with different magnifying powers on two spectroscopes—the one with a single prism of 60°, the other, the "four-prism" spectroscope (*loc. cit.*, p 49).

We came to the conclusion that a marked feature of this line is its sharply-defined character on the more refrangible side; we were

unable, under any of the conditions of observing, to detect even a suspicion of any softening of the more refrangible edge of the line, much less the faintest indication of a "flare," and certainly not the distinctive peculiarity of a "fluting."

In the case of observations with small dispersion, the eye is helped by placing the second line, which then appears near the first, behind a bar fixed in the eye-piece.

Observations of the nebula in Orion by eye, as well as the photographs of Mr. Common and of Mr. Roberts, show numerous small irregularities in the brightness of the nebula, which give rise to a closely-mottled appearance. As the length of the slit takes in a considerable angular extent of nebula, several of these irregularities of brightness or "mottlings" are usually included within it, giving to the nebular lines an irregularly bright or blotchy appearance. As the nebula is allowed to pass over the slit this blotchy appearance is seen to vary in the size and in the number of the brighter patches, and also in their brightness relatively to the less luminous spaces between them. At the first glance, in some positions of the slit upon the nebula, the lines, and especially the principal line as the brightest, appear almost as if serrated at the edges. A little attention soon shows that this is a purely physiological effect due to the greater brightness of the patches, and that the brighter parts of the line do not really project beyond the less brilliant intervals between them. One marked character of this phenomenon is that both edges of the lines appear equally serrated, and that there is no indication of a spreading of the brighter patches towards the blue only. It is easily ascertained that this more or less patchy condition is not peculiar to the principal line, for precisely the same patches can be detected in the other two lines, and the patches can be seen to correspond in number and in position within the lines.

These observations, repeated on several nights, have left no doubt in our minds that the principal line is certainly as sharp and as bright on the side towards the blue as on the less refrangible side.

On February 9, Professor Liveing scrutinised the character of this line. His words are:—"Observed the nebular line with various widths of slit. The line always appeared sharply defined on the more refrangible side, whether the slit were wide or narrow. On gradually closing the slit, the line fined down to a very fine line. The same appearance as to sharpness on the more refrangible side was observable with a spectroscope of less dispersive power and with eye-pieces of low power as with the higher dispersion and greater magnification."

The observations recorded in this paper appear to us to show conclusively:—

(1.) That the principal line is not coincident with, but falls within, the termination of the magnesium-flame band.*

(2.) That in the nebula of Orion this line presents no appearance of being a "fluting."

It is scarcely needful to say that, in the face of the observations recorded in this paper, we are not able to accept the conclusions arrived at by Professor Lockyer in his recent communications† to the Royal Society. From them it would appear that Professor Lockyer confirms my statement made in 1874,‡ that the second line "is sensibly coincident with an iron wave-length 4957" (Thalén, λ 4956·8; Liveing and Dewar, λ 4956·9); and also that Professor Lockyer's photographs confirm my photographs of 1882, 1888, and 1889, in that it is a single strong line, and not a triplet, which appears in the ultra-violet region, and that this strong line is more refrangible than the first component of the magnesic oxide triplet.§

Addendum. Received June 6, 1890.

1. *Addendum on the Position of the Line.*

One of the planetary nebulæ, in the spectra of which I found in my earlier comparisons with lead‖ in 1874, that the principal line had sensibly the same position as the corresponding line in the nebula of Orion was Σ. 5 (G. C. 4234). We have now compared again the principal line in this nebula with the lead line λ 5004·5 with the same spectroscope (spectroscope B, 3rd eye-piece) and an arrangement for

* [Even if the nebular line appeared to be sensibly coincident under the amount of dispersion which can be brought to bear upon the nebulæ, for reasons stated in our paper of last year (*loc. cit.*, p. 55, foot-note), the evidence would be strongly in favour of the view that the coincidence was apparent only, and against the assumption that the nebular line was to be regarded as the "remnant" of the magnesium-flame band. We did not, however, give sufficient prominence to the fact of the great brilliancy of the line in many nebulæ, without the faintest traces of the second and third flutings. The relative intensities of the brightest ends of these flutings are:—

1st fluting	8
2nd ,, ...	7
3rd ,, ...	5

(Watts, 'Index of Spectra,' p. 175). However, the position of the nebular line at a measurable distance from the terminal line of the magnesium-flame band towards the blue makes such considerations superfluous, and disposes finally of the assertion that the nebular line is the "remnant" of the magnesium fluting.—July 4.]

† 'Roy. Soc. Proc.,' vol. 47, p. 129 and p. 189, &c.

‡ 'Roy. Soc. Proc.,' vol. 22, p. 252.

§ 'Roy. Soc. Proc.,' vol. 46, p. 54.

‖ 'Roy. Soc. Proc,' vol. 22, 1874, p. 254.

the comparison spectrum similar to that described in the first part of this paper, but in which the small mirror has been replaced by a very small total reflecting prism. The correctness of position of the comparison spectrum was ascertained by repeated comparisons of the bright lines of magnesium at *b* with the corresponding dark lines in the Sun's light reflected from the sky.

When in this spectroscope the spectrum of lead is observed together with that of burning magnesium, the lead line is seen to fall well within, and to be separated by a clear space from, the terminal line of the magnesium-flame fluting.

The principal line of Σ. 5, like that of the nebula of Orion, appears when the slit is made narrow to be very thin and clearly defined at both edges. The lead line is a thin and defined line; if, therefore, the nebular line were coincident with the terminal line of the magnesium-flame fluting, it would appear in the spectroscope to be separated by a clear space from the lead line towards the red. As the angular diameter of the nebula is small, the line is much shorter than the lead line—not longer than about one-third of the height of the spectrum, and consequently its position relatively to the lead line, even when it falls partly upon it, can be very accurately determined.

The nebular line was seen as a short thin bright line partly upon, and partly clinging to, the lead line. The nebular line in our instrument certainly fell upon the lead line, but overlapped it a very little, though not so much as by half its breadth, on the less refrangible side. This position agrees precisely with that described in my early observations made nearly twenty years ago, when I employed for the first time lead as a fiducial comparison line.* As I stated in 1874,† "if greater prism power could be brought to bear upon the nebulæ, the line in the lead spectrum would be found to be in a small degree more refrangible than the line in the nebula;" and, of course, if sufficient power of dispersion were employed, the nebular line would be seen separated from the lead line towards the red, and not, as in our instrument, partly upon the lead line.

These observations, both those by myself in 1874 and the recent observations made by both of us independently on four different nights, place the nebular line exactly where it was ound to be by our direct comparisons with burning magnesium in the nebula of Orion (which were confirmed by Professor Liveing), namely, as not coincident with, but as falling well within, the terminal line of the magnesium-flame spectrum.

It should be stated that on two nights we made comparisons of Σ. 5 with burning magnesium, both directly, and indirectly by means of the illuminated pointer. The observations completely confirmed

* 'Roy. Soc. Proc.,' vol. 22, p. 252.

† *Ibid.*

the results of the lead comparisons, which were, however, more easily made, as it is difficult to see the exact position of the short nebular line when it is upon the bright fluting.*

2. *Addendum on the Character of the Line.*

I am permitted by Dr. Copeland, Professor Young, and Mr. Keeler, of the Lick Observatory, to quote the following observations, which they have been so kind as to make at my request, of the character of the principal line in the spectrum of the Great Nebula in Orion.

Dr. Copeland writes, dated March 26, 1890: "I find it difficult to make anything satisfactory of nebular spectra with my present apparatus, working in the smoke of Edinburgh . . . . . On the 14th I saw the three lines as well as I am likely to see them until we get to work at the new observatory. All the lines were just as broad as the slit; when the slit was wide open they were broad, and when the slit was closed slowly they gradually became narrower and narrower."

Professor Young, writing on March 21, 1890, says: "I have not been able this winter to try the observations for wave-length, having no convenience for the comparison spectrum, but I have carefully examined the spectrum of the nebula of Orion, both with a heavy glass prism, and with a grating of 14,000 to the inch, and a collimator of 16 inches focus. With the prism the brightest nebular line seemed absolutely *sharp*, and cleanly defined on both sides; with the grating the line was fainter, and I could not use so narrow a slit, the dispersion was much higher also; the line therefore was a little hazy, *but equally so on both sides.*"

At the Lick Observatory there was a continuance of bad weather during the early months of the year, but Mr. Keeler, with Dr. Holden's kind permission, observed the nebula on two nights. He observed successively with one prism, a powerful compound prism, and then with a Rowland grating, 14,000 + lines to the inch. With this grating, the collimator was 20 inches in length, the observing telescope $10\frac{1}{2}$ inches, with an eye-piece magnifying 13·3 times. The slit was narrow, 0·0025 inch. The spectra up to the fourth order were employed.

Mr. Keeler says: "One thing that struck me particularly, and that there could be no doubt of, was the perfect sharpness and

* [On one night, as had been frequently done when we were observing the nebula in Orion, after the comparison of the nebula with lead and magnesium had been made, the spectroscope was left attached to the telescope in order that we might verify the correctness of position of the comparison spectrum by means of the light of sky on the following day, without any change whatever having taken place in the adjustments of the instrument. The result of this verification was, as always when working on Orion, absolutely satisfactory.—July 4.]

fineness of the nebular lines under the very considerable dispersion used. There is not the least doubt in my mind that they are all of gaseous origin—not 'remnants of flutings.'"

[The observations with large dispersion by Professor Young, and especially those of Mr. Keeler, after observing with one prism, and then with a compound prism, that the line remained sharp even when examined in the 4th spectrum of a grating 14,000 + to the inch, are of great value in regard to Mr. Maunder's observations. It was on one occasion only when he made use of the very great dispersion of 80° from A to H, equal to about sixteen prisms of 60°, that he observed the nebular line to be otherwise than sharp and defined. On this unique occasion he says: "The three lines were seen as narrow bright lines, but none of them were perfectly sharp; each showed a slight raggedness at both edges, but in the case of the line near λ 5005 it was clear that this fringe or raggedness was more developed towards the blue." Mr. Maunder significantly adds: "In the case of the other two lines they were not bright enough for it to be possible to ascertain whether the fringes were symmetrical or not." * The new observations at Princeton and at the Lick Observatory would seem to leave little doubt that if the other lines had been as bright as the principal line, the raggedness about them would have been found to be equally unsymmetrical, and that the want of symmetry affected all three lines, and was probably instrumental.—July 4.]

Second Addendum. Received July 4.

On the Position of the Line.

On account of the unusual weather at the Lick Observatory during the early part of this year, Dr. Holden informs me that "The observing chances have been amazingly small." For this reason, although, in addition to the observations on the character of the chief line in the nebula of Orion, measurements of its position were attempted on two nights, the interruption from clouds was so constant that they could not be satisfactorily completed.

Under these circumstances, I asked Dr. Holden to have the kindness to telegraph to me if Mr. Keeler should be able to confirm the position of the line as not coincident with the magnesium-flame fluting in the nebula Σ. 5.

On June 15th, I received a telegram with the words: "Confirmed Struve. 5. Keeler."

I have received since a letter from Mr. Keeler, dated June 14th, 1890, in which he says:—"Last night I compared the brightest line

* 'Monthly Notices, R. A. S.,' vol. 49, 1889, p. 308.

in the spectrum of Σ. 5 with the magnesium fluting of nearly the same wave-length, and I am glad to say that my observations were in accordance with your own." . . . . "On comparing the brightest line with the magnesium fluting, both directly and by aid of the micrometer wire, the line was seen to be well within the limits of the fluting, and separated by a small but unmistakable interval from its bright lower edge. The appearance was the same on both sides of the grating, and in the 3rd and 4th spectra. The comparison apparatus was carefully adjusted, and no shifting of the line was caused by changing the position of the spark. The edge of the fluting *could not* be brought into coincidence with the nebular line. No measurement of the difference of wave-length was made, as my attention was directed to the main fact of the non-coincidence of the line in all positions of the instrument. I will make such measures as soon as possible."

"Note on the Photographic Spectrum of the Great Nebula in Orion." By WILLIAM HUGGINS, D.C.L., LL.D., F.R.S., and Mrs. HUGGINS. Received April 16,—Read June 12, 1890.

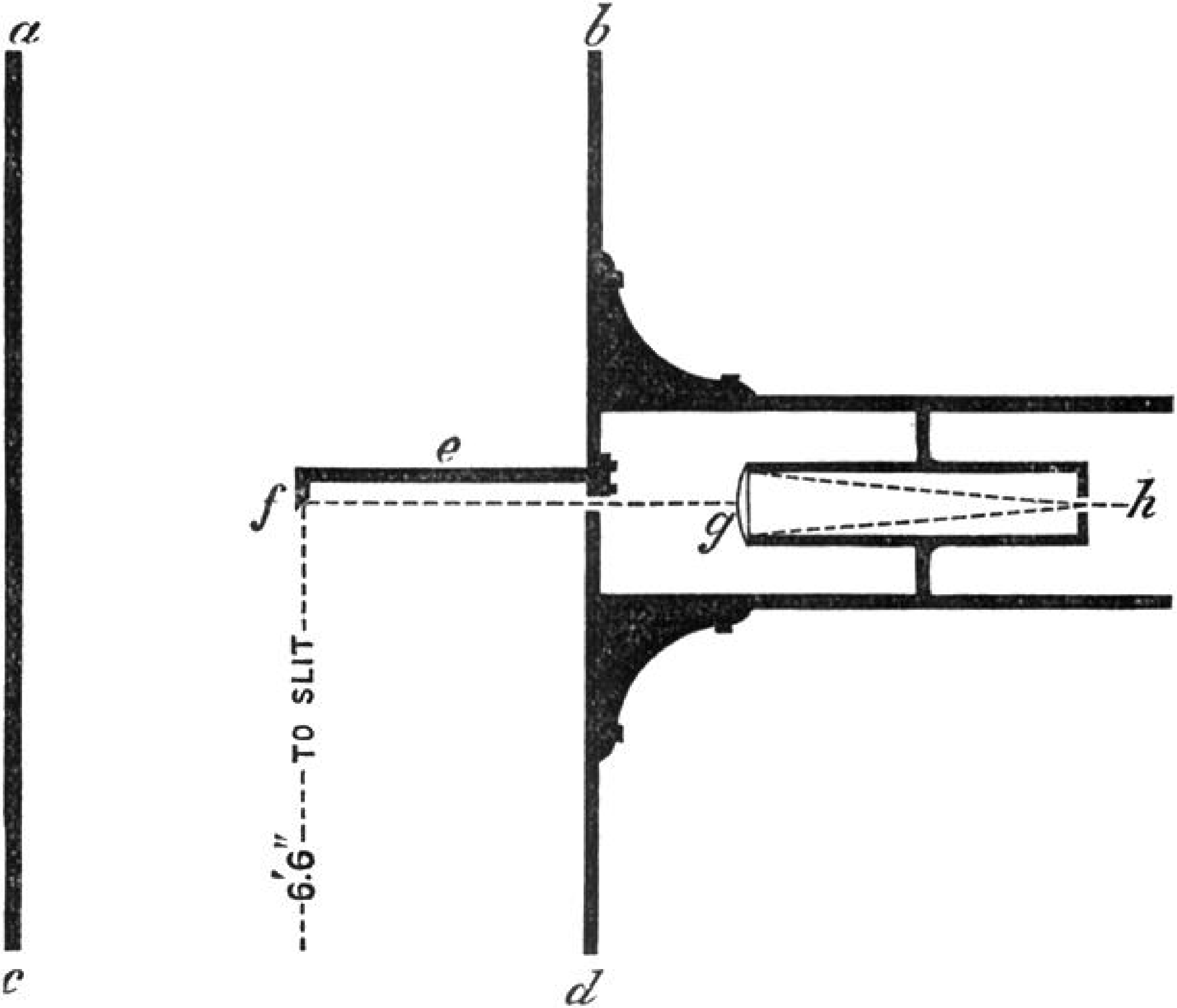
From an examination of the photographs of the spectrum of the nebula in Orion taken by us in 1882, 1888, and 1889, we suggested in our paper "On the Spectrum, Visible and Photographic, of the Great Nebula in Orion,"* "that the mottled and broken-up character of the nebular matter shown in Lord Rosse's drawings from eye-observations, and much more strikingly brought out in the recent photographs of Mr. Common and of Mr. Roberts, may be connected with differences of spectrum in the photographic region, though in the visible region there is no known alteration of the spectrum of the four bright lines, except it may be some small differences of relative brilliancy of the lines. Until next winter we cannot go beyond the new information which these photographs give to us."

Unfortunately, the necessity thrown upon us of making a laborious redetermination of the position and character of the principal line in the visible spectrum,† which has confirmed in every point the results contained in our paper of last year (*loc. cit.*), has deprived us of the more favourable opportunities during the past season of carrying out our intention of photographing the spectra of different parts of the nebula.

We have obtained two photographs only, one taken on March 14th and 15th, and the other on March 17th; but these suggest how much

* 'Roy. Soc. Proc.,' vol. 46, p. 42.

† 'Roy. Soc. Proc.,' vol. 47, pp. 129 and 189, &c.



a
b
c
d
e
f
g
h
6.6" TO SLIT